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RD Research Report
Number RDD-01-01

July 2001

Evaluation of Score Functions to Aid in the 2002 Census of Agriculture Review Process

2001 AUG 22 P 1:00

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EVALUATION OF SCORE FUNCTIONS TO AID IN THE 2002 CENSUS OF AGRICULTURE REVIEW PROCESS, by Denise Abreu, Sampling and Estimation Research Section, Research and Development Division, National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, D.C. 20250, July 2001, Report No. RDD-01-01

ABSTRACT

The National Agricultural Statistics Service (NASS) has expressed concern about the cost effectiveness of survey editing. This is particularly true since 1997 when NASS assumed the responsibility for the census of agriculture for which hand-editing of all questionnaires is not feasible. In the 1997 Census of Agriculture, all reported data were keyed and then edited by computer. There was no attempt to sort the records according to importance of review. Records flagged for review during the computer edit were reviewed in the order in which they were keyed. Thus time was spent reviewing records which had little impact on any county estimates. Some important records which should have been reviewed more thoroughly probably were not, due to time constraints.

Survey estimates can be improved by priority sorting the records so that those records that are more likely to contain errors which will have a significant effect on the county estimates are reviewed first. This priority sorting of records for review is accomplished by first applying a score function and then sorting the records.

This paper presents an evaluation of three score functions thought to be most suitable for data collected by NASS. The ultimate goal is to reduce the labor-intensive manual review of data without damaging data quality. The results indicate that using a score function presents an improvement over the previous way of reviewing census records. The paper provides detailed information on each score function, the methodology followed to evaluate each function, the recommended score function to use, and some thoughts for further research.

KEY WORDS

Census of agriculture; Survey editing; Difference score; Magnitude score; Ratio score.

This paper was prepared for limited distribution to the research community outside the U.S. Department of Agriculture. The views expressed herein are not necessarily those of NASS or USDA.

ACKNOWLEDGMENTS

The author would like to thank Wendy Scholetzky and Dale Atkinson for their continued support with this project and their guidance during the creation of this report. Additional thanks to Chadd Crouse and Kara Perritt for their valuable insights and comments on this project and to Mike Hogye for his tremendous help preparing the SAS graphs.

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SUMMARY

The National Agricultural Statistics Service (NASS) has expressed concern about the cost effectiveness of survey editing. This is particularly true since 1997 when NASS assumed the responsibility for the census of agriculture for which hand-editing of all questionnaires is not feasible. For these reasons, NASS is conducting an evaluation of its current editing process. The ultimate goal is to reduce the labor-intensive manual review of data without damaging data quality.

Survey estimates can be improved by priority sorting the records so that those records that are more likely to contain errors which will have a significant effect on the county estimates are reviewed first. This priority sorting of records for review is accomplished by first applying a score function and then sorting the records. A score function produces a score for each record such that (theoretically) the higher the score the more important it is to review that record. The score may be a function of the magnitude of the record (e.g. for each variable, the percentage that record contributes to the sum over all records). It may also depend on the amount that the record has changed since the previous reporting period.

Three candidate score functions were chosen for evaluation in ordering the farm records in the next census. The difference score function uses the absolute difference between variables, the ratio score function uses the ratio of variables, and the magnitude score function is the same as the difference function except it does not use record-level data from the previous period. The 1997 Census of Agriculture data from Michigan and Arkansas were used to evaluate the score functions. Michigan data were selected for the evaluation largely due to the diversity of agriculture in the state. Arkansas data were chosen since it has a different set of farm characteristics than Michigan. Characteristics such as farm acreage, total value of products sold, acres harvested, and inventory among others were used to score the records in both states.

The results showed all three score functions being an improvement over the actual review order. The difference and magnitude score functions are comparable when determining review order for records with historical data. Also, both score functions outperformed the ratio function. When records were processed in batches the score functions showed some loss in efficiency, however all three functions still presented an improvement over the actual review order. As a result of the analysis, the recommendation is to use the magnitude score function for the 2002 Census of Agriculture.

I Introduction

Historically, the focal point of the editing process was on correcting all or as many errors in a survey as possible. However, in recent years the survey editing process has been the focus of serious evaluations and re-engineering in many organizations. This change in focus was primarily because of the high cost associated with editing all records instead of concentrating on those records that could significantly improve survey results (Latouche and Berthelot, 1992; Lawrence and McDavitt, 1994).

To address this issue, survey researchers have come up with techniques such as significance editing and selective editing. These methods consist of reducing and prioritizing the editing workload by examining individual records based on their potential impact on the estimates. Basically, the new view on editing is to prioritize the order in which the records are edited so that the most important records are addressed most rigorously (Lawrence and McDavitt, 1994). By ignoring records of less aggregate impact, editing resources can be reduced significantly. Respondent burden is also reduced since the amount of respondent recontact is minimized. This will in turn lead to an improvement in the overall quality of the final estimates since resources are used for a more extensive follow-up of the most important records (Lawrence and McKenzie, 2000). To prioritize the order in which records are reviewed requires the use of a score function (Latouche and Berthelot, 1992).

The National Agricultural Statistics Service (NASS) has expressed concern about the cost effectiveness of survey editing. This is particularly true since 1997 when NASS assumed the responsibility for the census of agriculture for which hand-editing of all questionnaires is not feasible. For these reasons, NASS is conducting an evaluation of its current editing process. The ultimate goal is to reduce the labor-intensive manual review of data without damaging data quality.

In the 1997 Census of Agriculture, all reported data were keyed and then edited by computer. The format and simple edit procedure flagged selected problem cases for review. However, there was no attempt to sort the records according to importance of review. Records flagged for review during the computer edit were reviewed in the order in which they were keyed. Thus time was spent reviewing records which had little impact on any county estimates. Some important records which should have been reviewed more thoroughly probably were not, due to time constraints.

Survey estimates can be improved by priority sorting the records so that those records that are more likely to contain errors which will have a significant effect on the county estimates are reviewed first. This priority sorting of records for review is accomplished by first applying a score function and then sorting the records.

This paper evaluates three widely used score functions thought to be most suitable for data collected by NASS. The analysis is done using 1997 Census of Agriculture data from Michigan and Arkansas. Section II provides detailed information on each score function. Section III describes the procedure followed to evaluate each function. Sections IV and V present the results for Michigan and Arkansas, respectively. Section VI offers the recommended function to use, and Section VII provides some thoughts for further evaluation.

II Score Functions

A score function produces a score for each record such that (theoretically) the higher the score the more important it is to review that record. The score may be a function of the magnitude of the record (e.g. for each variable, the percentage that record contributes to the sum over all records). It may also depend on the amount that the record has changed since the previous reporting period.

Three candidate score functions were chosen for evaluation in ordering the farm records in the next census. Although the three score functions evaluated use multiple input variables to produce a score, none take into consideration the covariance of the input variables. For example, in many places one would expect cattle farmers to grow hay for winter feed. One would further expect hay acreage to increase as the number of cattle increased. A deviation from the typical relationship between the two variables might indicate that a farm record contains bad data. None of the three candidate score functions would detect such a deviation.

The first candidate score function uses the absolute difference between variables, so the scores it produces will be referred to as difference scores. It is attributed to Latouche and Berthelot (1992), and is currently used in the Department Of Energy's GEAQS edit system. A record's difference score is calculated as

$$\sum_{i=1}^{n} |x_{i,t} - x_{i,t-1}| / X_{i,t-1}$$

Here i indexes n farm characteristics, x is a farm characteristic, X is the total for the characteristic, and t indexes time (current or previous reporting period.) When $X_{i,t-1}$=0, the corresponding term of the series is set equal to zero.

The second candidate score function, attributed to Hidiroglou and Berthelot (1986), uses the ratio of variables. The scores it produces will be referred to as ratio scores. The calculation of a record's ratio score is as follows:

$r_i = x_{i,t} / x_{i,t-1}$, where x, i, and t are as described earlier

Find r_{mi} the median of the r_i, and calculate

$$s_i = 1 - (r_{mi} / r_i) \quad \text{if } r_i < r_{mi},$$
$$= (r_i / r_{mi}) - 1 \quad \text{if } r_i \geq r_{mi}$$

$$E_i = x_{\max_i} * s_i$$

where $x_{\max_i} = \max[x_{i,t}, x_{i,t-1}]$

Find E_{1i}, E_{mi}, and E_{3i} -- the first quartile, median, and third quartile of the E_i -- and calculate

$$D_i = |(E_i - E_{mi})| / (E_{3i} - E_{1i})$$

The ratio score for a record is $\sum_{i=1}^{n} D_i$.

The ratio r_i has three undesirable properties. First, r_i is undefined when $x_{i,t-1}$ equals zero. But, if $x_{i,t}$ is nonzero then this situation may correspond to a significant increase in characteristic x_i. This problem is fixed by setting $x_{i,t-1}$ equal to one whenever $x_{i,t}$ was nonzero. Second, r_i is equal to zero when $x_{i,t}$ equals zero and $x_{i,t-1}$ was nonzero. Thus, it does not take into account the magnitude of $x_{i,t-1}$. This problem is partially fixed by setting $x_{i,t}$ equal to 1 before calculating r_i. If both $x_{i,t}$ and $x_{i,t-1}$ equal zero, the ratio

was not calculated and did not contribute to the ratio score. Third, r_i is greater than one when $x_{i,t}$ is greater than $x_{i,t-1}$; but r_i is between zero and one when $x_{i,t}$ is less than $x_{i,t-1}$. So, the distance from r_{mi} for an r_i to be perceived as an outlier depends upon which side of r_{mi} the r_i lies. This problem is fixed by utilizing s_i and E_i to produce the ratio score.

The third candidate score function is the same as the difference function except it does not use record-level data from the previous period (i.e., $x_{i,t-1}$). The scores it produces will be referred to as magnitude scores. Similar to Luzi and Pallara (1999) whose scoring technique extended the selective editing approach to fit cross-sectional surveys, the magnitude score function does the same by using previous data only at the aggregate-level in order to locate suspicious observations. A record's magnitude score is calculated as

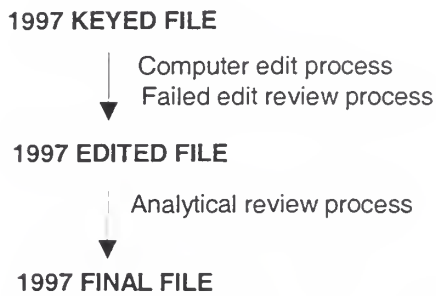
$$\sum_{i=1}^{n} \left[x_{i,t} \,/\, X_{i,t-1} \right]$$

Here i indexes n farm characteristics, x is a farm characteristic, X is the total for the characteristic, and t indexes time (current or previous reporting period). When $X_{i,t-1}=0$, the corresponding term of the series is set equal to zero. Note that totals are the only data required from the previous reporting period. When a farm record has no record-level data for the previous reporting period, this is the only score function of the three where scores can be computed.

To evaluate these score functions for the census of agriculture, county totals (weighted) and unweighted record-level data were used in calculating the three different types of scores. Unweighted record-level data were used because weights are not assigned until late in the review process. Using unweighted rather than weighted record-level data in the score functions will result in different scores and a somewhat different review order. However, the overall effect should be negligible since the census weights are small.

III Score Function Evaluation

The 1997 Census of Agriculture data were used to evaluate the score functions. The following diagram shows the general flow of census data processing in 1997. The differences in the files were mostly due to the processes listed on the right.



The 1997 keyed file contained census data after keying verification. The 1997 edited file represented the data after the computer edit and failed edit review processes. During the computer edit, records which "failed" the edit were flagged for further review (i.e., manual review by an analyst). As stated earlier, flagged records were reviewed in the order in which they were keyed. The failed edit review process focused on reviewing data at the micro-level (i.e., record-level). Note that there is no way to differentiate between manual review changes and computer changes on the edited file. The 1997 final file represented the data after the analytical review process. During this process, record-level data were changed after reviewing state and county totals. The analytical review process focused on

reviewing data at the macro-level (i.e., totals).

To evaluate the impact of incorporating a score function during the failed edit review process, only records reviewed during the failed edit review process were included in the analysis. To obtain the necessary data, the 1997 final and edited files were matched to the 1992 final file. The resulting file was subsetted to include only records on the 1997 final file which were reviewed during the failed edit review process. Records were scored and then sorted using each of the three candidate functions. All three score functions used data from the 1997 edited file for the $x_{i,t}$. The ratio and difference score functions also used data from the 1992 final file for the $x_{i,t-1}$. The 1992 county totals were obtained and used as the $X_{i,t-1}$ in the difference and magnitude score functions.

As stated earlier, manual review changes could not be differentiated from computer changes on the edited file. Thus, the effectiveness of the score functions was evaluated through the use of a review adjustment score which measured changes made during the analytical review process. Data from the 1997 final and edited files were used to calculate a review adjustment score for each record in the subset described above. A record's review adjustment score indicates the importance of reviewing that record (the score is higher for records with significant analytical review changes). The review adjustment score is calculated as

$$[\sum_{i=1}^{n} |x_{i,k} - x_{i,k-1}| / X_{i,k}]$$

Here i indexes the n farm characteristics being examined, x and X are as described before, k corresponds to the 1997 final file, and k-1 corresponds to the 1997 edited file.

To reiterate, the review adjustment score takes into account changes made only during the analytical review process of records flagged during the failed edit review process.

The percentage of total review adjustment contributed by the record was also calculated to indicate the relative importance of reviewing a record with respect to other records. The percentage of total review adjustment contributed by the record is

$$\left[\frac{[\sum_{i=1}^{n} |x_{i,k} - x_{i,k-1}| / X_{i,k}] \div}{[\sum_{j=1}^{m} \sum_{i=1}^{n} |x_{j,i,k} - x_{j,i,k-1}| / X_{i,k}]} \right] * 100$$

where j indexes the m records on the 1997 final file which were reviewed during the failed edit review process. Also, i indexes the n farm characteristics being examined, x and X are as described before, k corresponds to the 1997 final file, and k-1 corresponds to the 1997 edited file.

Graphs 1 through 8 in the appendix compare the results of scoring the records using the three proposed score functions against the actual review order. The cumulative percentage of the total review adjustment is plotted along the vertical axis. The horizontal axis represents the number of records reviewed as specified by the method. For example, record reviewed #10 could (most likely would) be a different record under the actual, magnitude, difference, and ratio score functions. Also, the scale of the horizontal axis varies since all records do not have record-level data for the previous reporting period. Thus, each line in the graphs depicts the percentage of total review adjustment for the review order specified by

each one of these methods. Graphs 1-4 present the results for Michigan and Graphs 5-8 for Arkansas.

IV Michigan Data

Michigan data were selected for the evaluation largely due to the diversity of agriculture in the state. In Michigan there were 6,698 records on the 1997 final file which were reviewed during the failed edit review process. Of these records, there were 1,496 records where data were changed between the 1997 edited file and the 1997 final file. Difference and ratio scores could not be calculated using all 6,698 records since 2,644 records were not on the 1992 final file (i.e., no historical data). Table 1 shows the distribution of the reviewed records and number of records that were actually changed by whether or not the record had historical data.

Table 1: Michigan Records Reviewed and Changed by Type of Data

Records	Number Reviewed	Number Changed
Historical data	4,054	953
No historical data	2,644	543
Total	6,698	1,496

A total of 18 variables were used to score the records in Michigan. These were total farm acreage; total value of products sold; total cattle and calves; milk cows; steers, steer calves, bulls and bull calves; total hogs and pigs; and acres harvested and production of the following: field corn for grain, field corn for silage, soybeans, potatoes, alfalfa, and winter wheat.

It was thought that the variables age, race, and gender might be useful for identifying records with historical data which should be reviewed. An operator's gender and race isn't likely to change from census to census, and the operator should age about five years. However, there were only a few records where at least one of these variables was changed during the analytical review process. Furthermore, it is difficult to properly score categorical variables. Therefore, these variables were not included in the analysis.

A. Michigan Records With Historical Data

There were 4,054 reviewed records which had historical data. Of these records, 953 were actually changed.

Graph 1 shows how the four different review orders identified records with analytical review changes which significantly affected county estimates. Ratio scores were a significant improvement from the actual review order. Difference and magnitude scores outperformed ratio scores with difference scores barely outperforming magnitude scores.

B. Michigan Records Without Historical Data

There were 2,644 reviewed records without historical data. These records could not be given ratio or difference scores since they did not have data for 1992. Thus, each of these records was assigned only a magnitude score. Of these records, 543 were changed.

Graph 2 shows that the magnitude scores were an improvement from the actual review order.

C. Michigan Records With and Without Historical Data

As previously stated, of the 6,698 reviewed

records with and without historical data, 1,496 were changed. Since the difference and ratio scores could not be calculated for records without historical data, the set of all reviewed Michigan records had to be evaluated using a score-combining scheme. Records with historical data used these methods while records without historical data were scored by magnitude. The scores were "standardized" as described below so that all records were comparably scored in the combined file. Difference scored records were sorted in ascending score order, and each record was assigned a new score equal to the cumulative difference score for that record divided by the total of all difference scores. This procedure was repeated on the records lacking historical data, using magnitude scores to produce new scores. The two sets of records with new compatible scores were then combined. The same procedure described above was also performed for ratio scores.

Graph 3 evaluates the three score functions after the score-combining scheme. The thin-solid line (labeled difference) shows the result of combining difference scores for records with historical data and magnitude scores for records without historical data. The thick-dotted line (labeled ratio) shows the result of combining ratio scores for records with historical data with magnitude scores for records without historical data. The thin-dotted line (labeled magnitude) shows the effectiveness of using magnitude scores for all records.

The results show that the ratio scores were outperformed by both difference and magnitude scores. Magnitude scores were more effective than difference scores up until 70 percent of the total review adjustment was reached, then difference scores outperformed magnitude scores.

D. Michigan Batch Processing

For the 1997 Census, records were processed in batches. When enough records were keyed in a state, the programmers were notified to run these records through the computer edit. This was referred to as an edit batch. Batches were formed chronologically based on the date of entry into the system. The number of records in an edit batch varied as did the number of edit batches in a state. However, the failed edit review process did not occur until the entire state was processed.

For the 2002 Census, plans are to perform the failed edit review process after each batch is processed. In order to evaluate the performance of the score functions considering the impact of batch processing, the batch process was simulated using 1997 Michigan data.

In Michigan, records were processed in two batches. To simulate the batching process, the 6,698 records were split into two groups with proportions equal to those of the actual edit batches. For the first group, 4,627 records were reviewed and 1,129 changed. Similarly, for the second group, 2,071 records were reviewed and 367 changed. Table 2 presents the distribution of the reviewed records and the number of records that were actually changed by whether or not the record within each edit group had historical data.

Table 2: Michigan Records Reviewed and Changed by Edit Group and Type of Data

Records	Number Reviewed	Number Changed
1st edit group	4,627	1,129
- historical data	2,675	703
- no historical data	1,952	426
2nd edit group	2,071	367
- historical data	1,379	250
- no historical data	692	117
Total	6,698	1,496

Scores were calculated using the score-combining strategy described in the previous section. The records were scored and sorted within each of the edit groups. Graph 4 presents these results.

For both edit groups, all three score functions presented an improvement over the actual review order. Although the second group had fewer records, the records accounted for 68% of the total review adjustment.

Scoring and reviewing distinct groups of records decreased the efficiency of the score functions. Using the magnitude score function as a point of reference, scoring all records together required reviewing 2,942 records to find 90% of the total review adjustment (See graph 3). From Graph 4, scoring the two distinct groups of records required reviewing 6,033 records to find 90% of the total review adjustment.

E. Michigan Conclusion

The graphs show all three score functions being an improvement over the actual review order. The difference and magnitude score functions are comparable when determining review order for records with historical data. Also, both score functions outperform the ratio function. The combining process introduces potential problems because of uncertainty about which scores are equivalent. The method of equating scores used in this report, resulted in the magnitude scores performing about the same as combining the difference and magnitude scores.

V. Arkansas Data

Arkansas data were chosen to evaluate the score functions since it has a different variety of farm characteristics than Michigan. In Arkansas, there were 7,187 records on the 1997 final file which were reviewed during the failed edit review process. Of these records, there were 1,308 records where data were changed between the 1997 edited file and 1997 final file. As was the case with Michigan, the difference and ratio scores could not be calculated using all 7,187 records since 2,328 records did not have historical data. Table 3 shows the distribution of the reviewed records and the number of records that were actually changed by whether or not the record had historical data.

Table 3: Arkansas Records Reviewed and Changed by Type of Data

Records	Number Reviewed	Number Changed
Historical data	4,859	864
No historical data	2,328	444
Total	7,187	1,308

A total of 26 variables were used to score the records in Arkansas. These were total farm acreage; total value of products sold; total cattle and calves; milk cows; steers, steer calves, bulls and bull calves; total hogs

and pigs; inventory and number sold of the following: layers 20 weeks old and older, broilers, and turkeys for slaughter; acres irrigated and production of rice; and acres harvested and production of the following: field corn for grain, field corn for silage, soybeans, cotton, alfalfa, and wheat.

A. Arkansas Records With Historical Data

There were 4,859 reviewed records which had historical data. Of these records, 864 were changed.

Graph 5 shows how the four different review orders identified records with analytical review changes which significantly affected county estimates. All three methods (ratio, difference, and magnitude) were an improvement over the actual review order. Difference scores slightly outperformed magnitude scores. Both difference and magnitude scores were a vast improvement over ratio scores.

B. Arkansas Records Without Historical Data

There were 2,328 reviewed records without historical data. For this reason, the calculation of difference and ratio scores was not possible. Thus, each of these records was assigned only a magnitude score. Of the records reviewed, 444 were actually changed.

Graph 6 shows that the magnitude scores were a tremendous improvement from the actual review order. With the magnitude score function, only 50 records needed to be reviewed to find 90% of the total review adjustment, while 1,112 records had to be reviewed to achieve the same mark with the strictly chronological (actual) process.

C. Arkansas Records With and Without Historical Data

As previously stated, of the 7,187 reviewed records with and without historical data, 1,308 were changed. The same score-combining strategy used with Michigan data was followed for Arkansas (see Section IV sub-section C for a description of this scheme). Graph 7 evaluates the three score functions after the score-combining scheme.

Once again, all three score functions presented an improvement over the actual review order. Also, difference and magnitude scores outperformed ratio scores. At first, magnitude scores performed better than difference scores, but then difference scores performed slightly better than magnitude scores. However, this shift in performance happened only after 90% of the total review adjustment had been obtained.

D. Arkansas Batch Processing

In Arkansas, records were processed in three batches. To simulate this process, the 7,187 records were split into three groups with proportions equal to those of the actual edit batches. For the first group, 1,972 records were reviewed and 252 changed. Similarly, for the second and third groups, 2,646 and 2,569 records were reviewed and 361 and 695 changed respectively. Table 4 presents the distribution of the reviewed records and the number of records that were actually changed by whether or not the record within each edit group had historical data.

Table 4: Arkansas Records Reviewed and Changed by Edit Group and Type of Data

Records	Number Reviewed	Number Changed
1st edit group	1,972	252
- historical data	1,224	168
- no historical data	748	84
2nd edit group	2,646	361
- historical data	1,686	214
- no historical data	960	147
3rd edit group	2,569	695
- historical data	1,949	482
- no historical data	620	213
Total	7,187	1,308

Scores were calculated using the score-combining strategy described in Section IV sub-section C. The records were scored and sorted within the edit groups. Graph 8 presents these results

For the first group of records processed, all score functions performed about the same. However, during the processing of the second group of records, the difference and magnitude scores outperformed both the ratio and actual scores. There was also a noticeable loss in efficiency for the ratio scores. For the last group of records, the magnitude and difference scores outperformed both the ratio and actual review scores.

E. Arkansas Conclusion

The graphs show how all three score functions present an improvement over the actual review order. The difference and magnitude score functions are comparable when determining review order for farm records with historical data. Difference and magnitude scores both outperform ratio scores. However, scoring and reviewing distinct groups of records decrease the efficiency of the score functions.

VI Recommendations

As a result of this analysis, the recommendation is to use the magnitude score function for the 2002 Census of Agriculture. However, it is important to note that batch processing will decrease the efficiency of this function.

The magnitude score function provides the following advantages:

a) It does not require using record-level data from the previous census. It only requires the use of county totals, which are readily available. This is very important since for both Michigan and Arkansas, a substantial number of records did not have historical data.

b) The fact that the magnitude score function only uses county level totals adds to its simplicity and ease of implementation. It will be easier to program and will take less time to run during production, since record-by-record file matching will not be needed.

c) The magnitude score function eliminates concerns over space allocation since there will be no need to maintain historical record-level data to support it.

d) Ultimately, there will be an improvement in the overall quality of the final estimates since resources will be used for a more extensive follow-up of the most important records as discussed in the Lawrence and McKenzie (2000) article.

VII Further Research

The current plan is to use data from the 1997 final file to address issues that need further examination, including but not limited to the following:

i. Should we use a unique list of variables for each state or a generic list of variables for all states? For example, broilers were used to score the records in Arkansas but not Michigan, potatoes were used to score the records in Michigan but not Arkansas. To simplify implementation, should we use a generic list which includes broilers, and potatoes regardless of the state under review?

ii. Whether we use a generic or unique list of variables, which variables should be used to score records? In other words, should we focus on only the major commodities in the state or include specialty items as well?

iii. Is the score function identifying records which are important to that particular state?

iv. Should we use a permanent file with county totals for every item of interest or should county totals be created on the fly during production?

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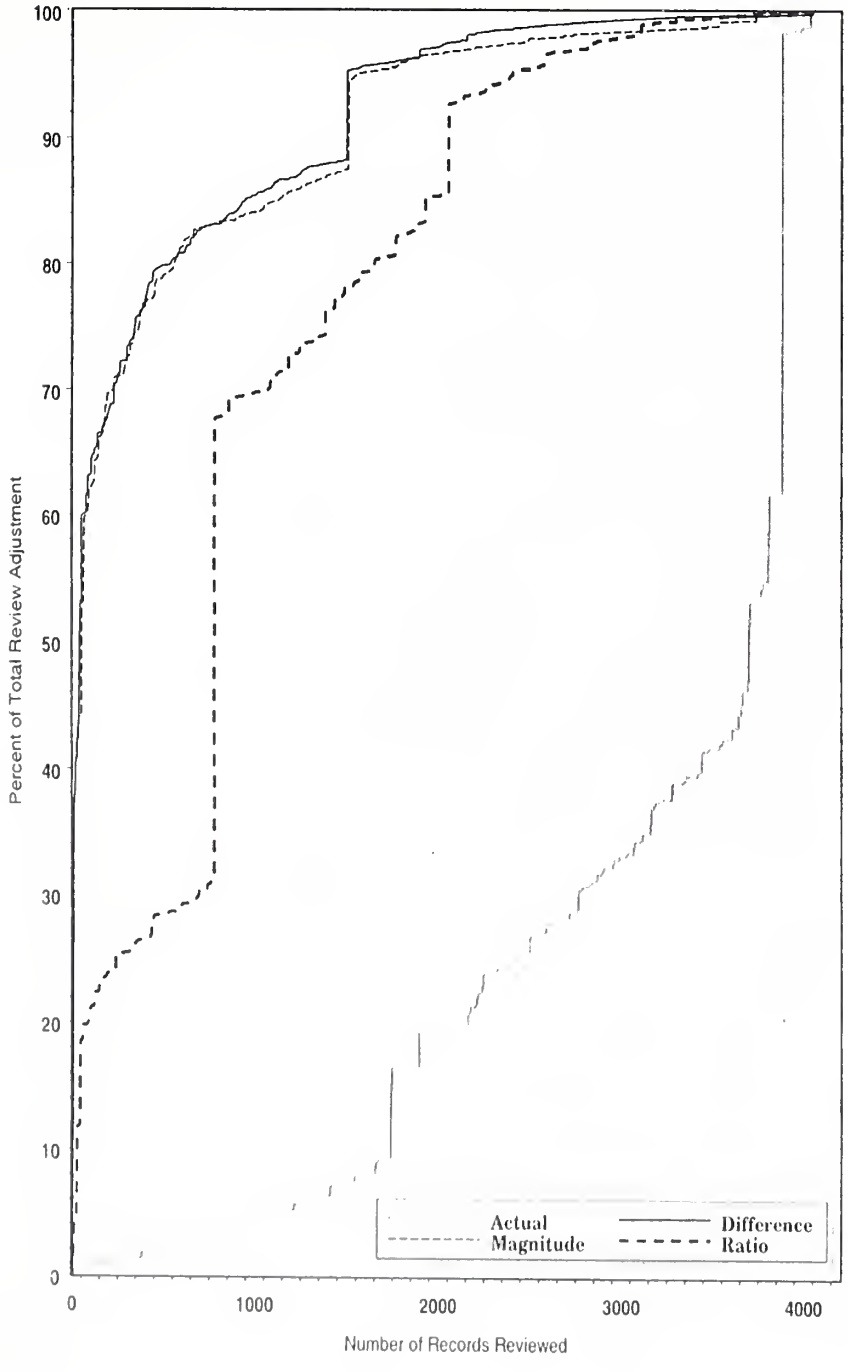
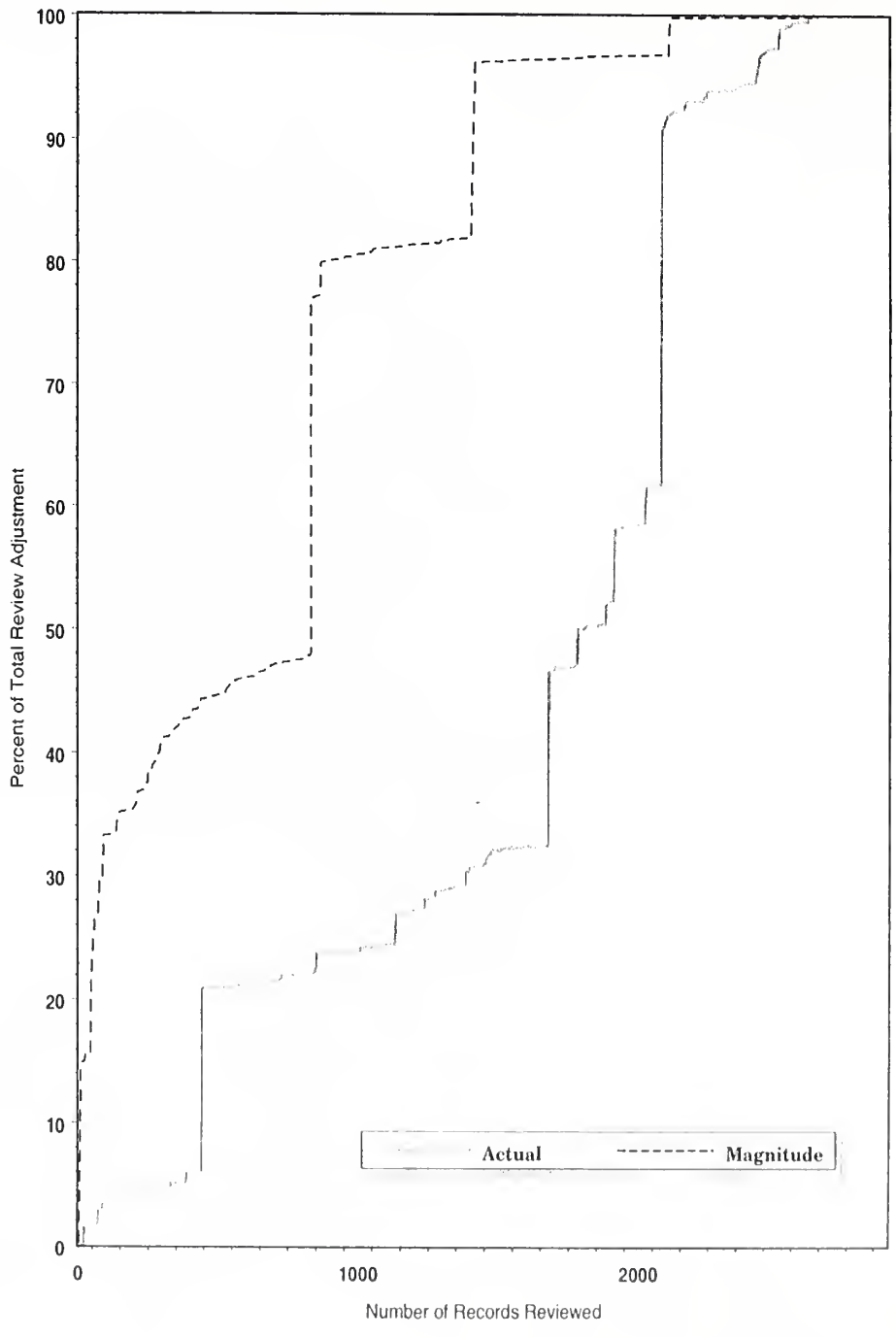
GRAPHS FOR MICHIGAN AND ARKANSAS

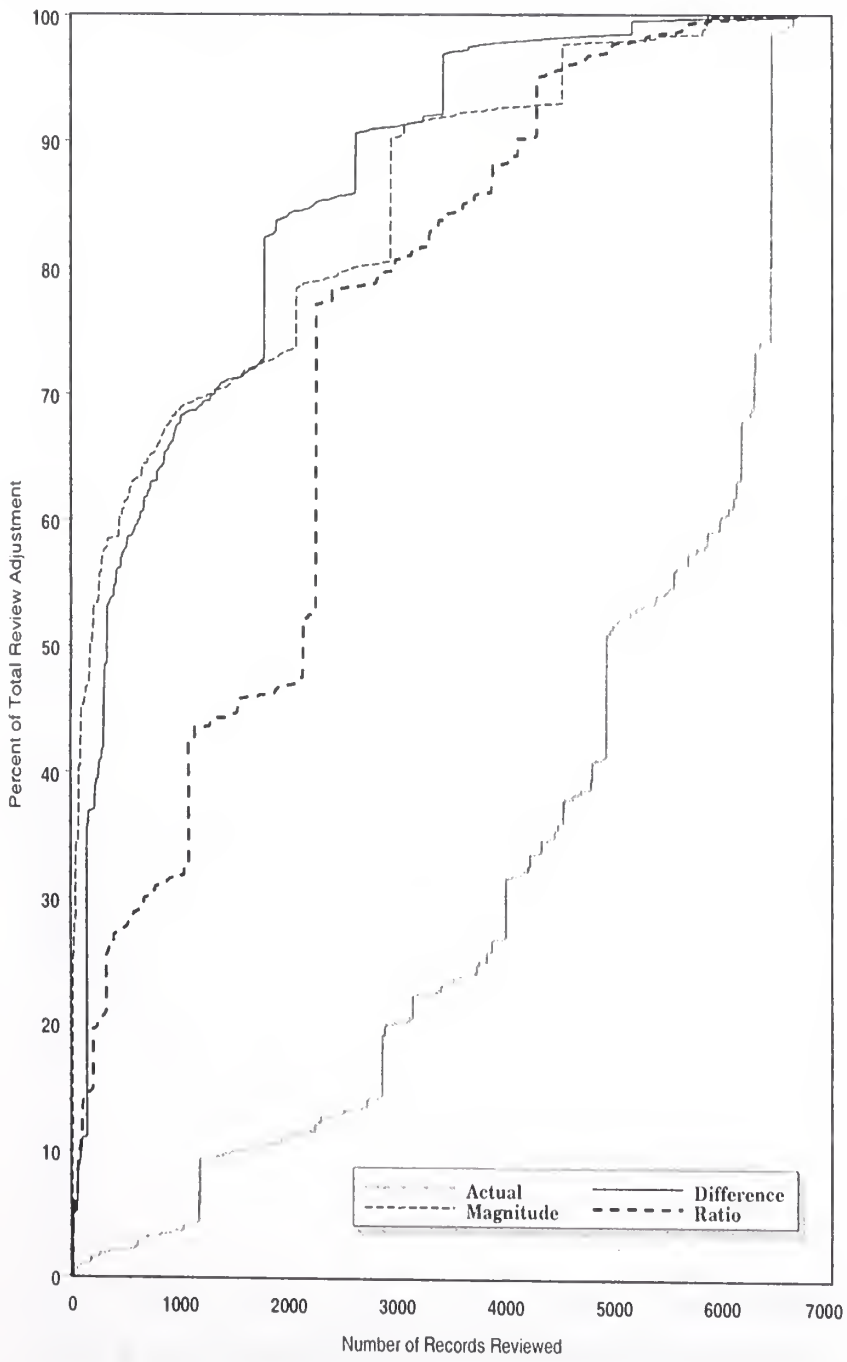
Graph 1: Scores Calculated for Michigan Records With Historical Data



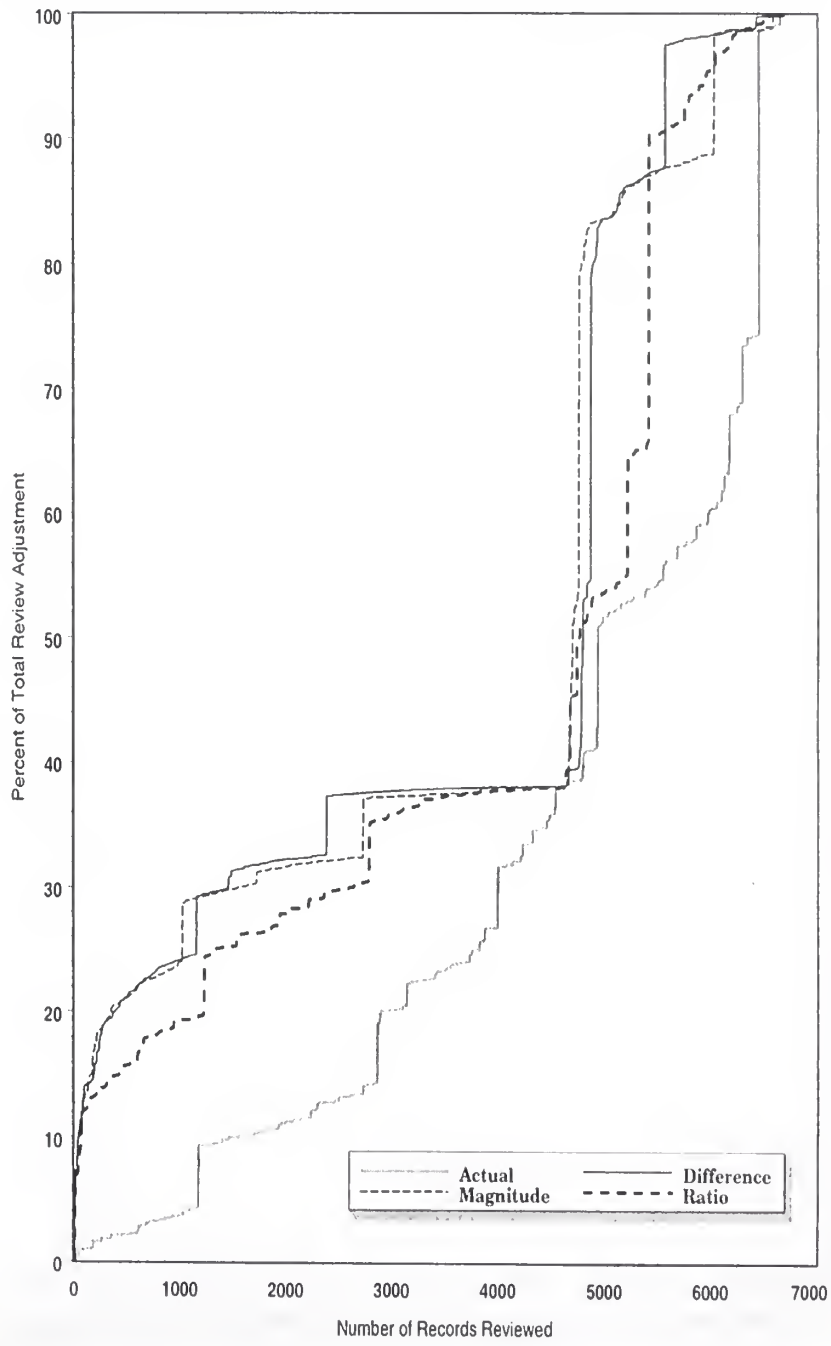
Graph 2: Scores Calculated for Michigan Records Without Historical Data



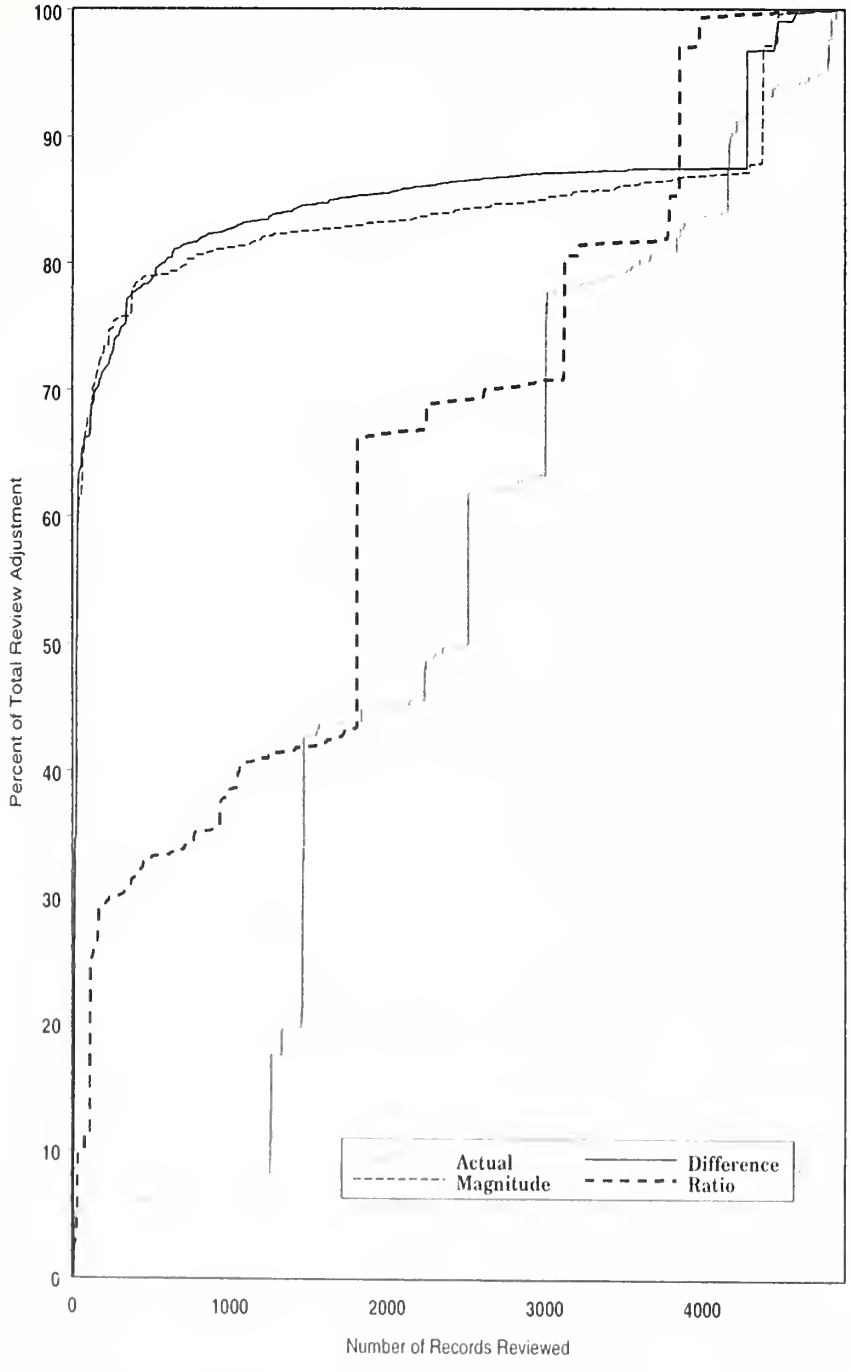
Graph 3: Scores Calculated for Michigan Records With and Without Historical Data



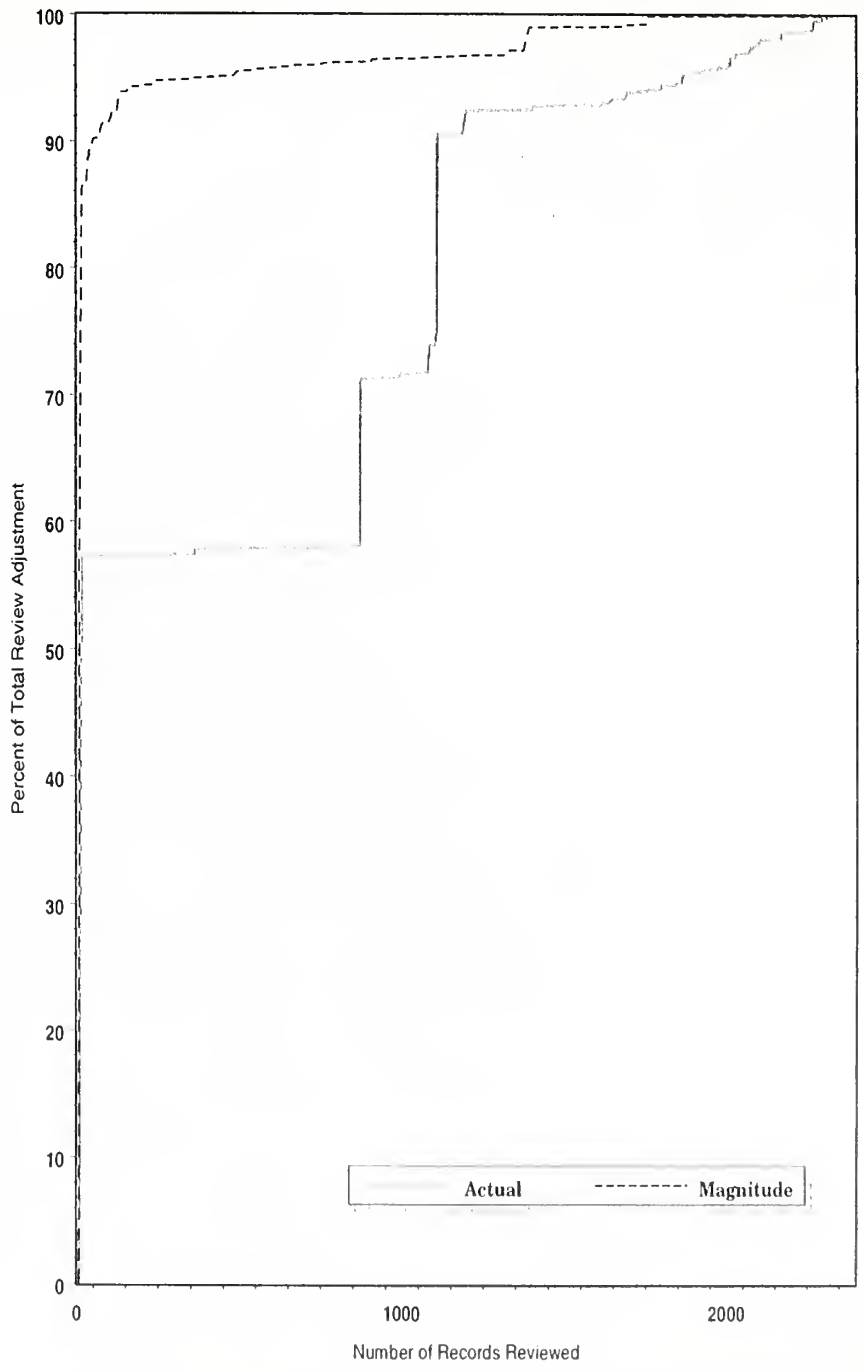
Graph 4: Scores Calculated for Michigan Records With and Without Historical Data by Edit Batch



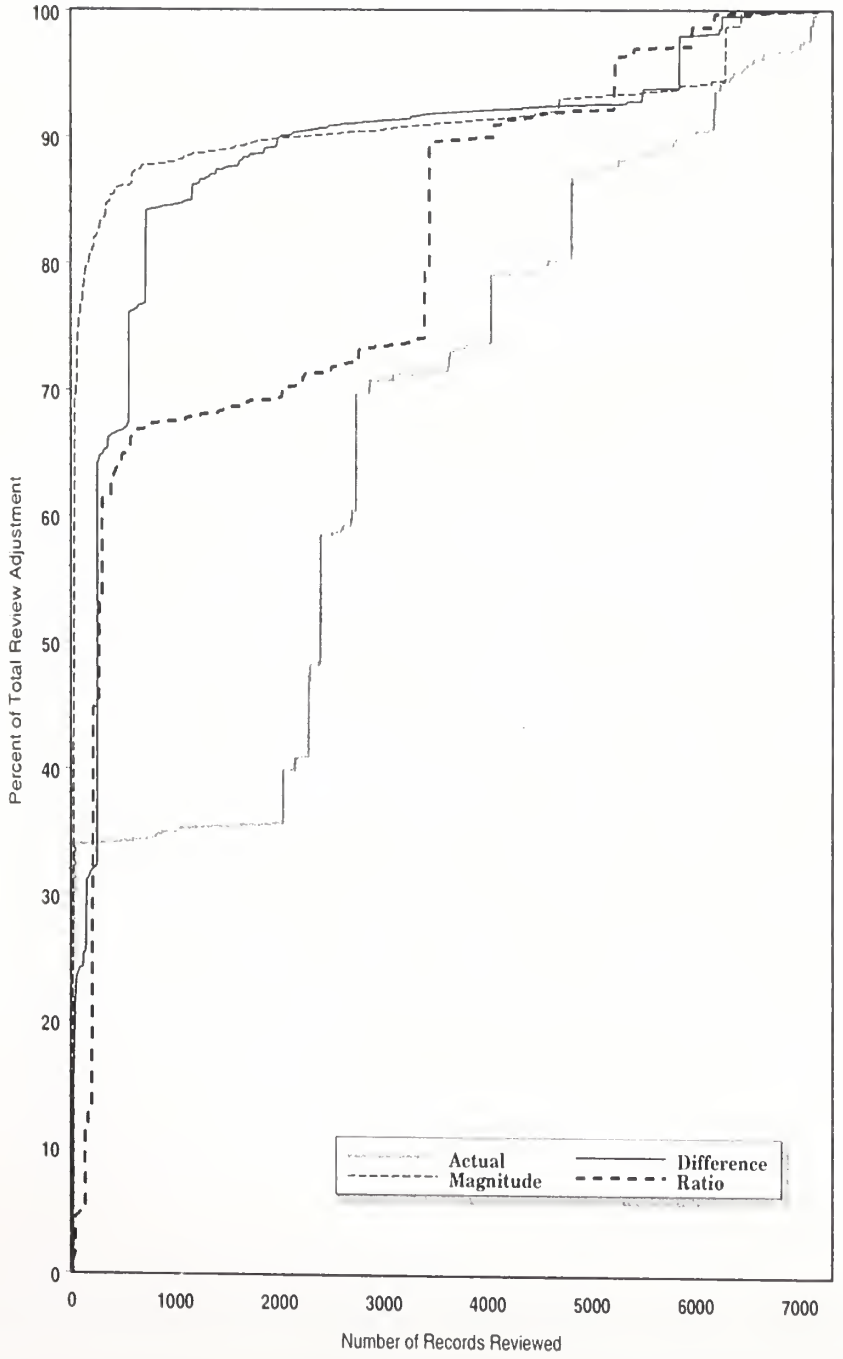
Graph 5: Scores Calculated for Arkansas Records With Historical Data



Graph 6: Scores Calculated for Arkansas Records Without Historical Data



Graph 7: Scores Calculated for Arkansas Records With and Without Historical Data



Graph 8: Scores Calculated for Arkansas Records With and Without Historical Data by Edit Batch